Sense of Coherence and Incidence of Periodontal Disease in Adults

Jai Kanhai[1]; **Victoria E. Harrison**[1]; **Anna L. Suominen**[2,3,4]; **Matti Knuuttila**[5]; **Antti Uutela**[2]; **Eduardo Bernabé**

[1] King's College London Dental Institute, Division of Population and Patient Health, London, United Kingdom

[2] National Institute for Health and Welfare, Helsinki, Finland

[3] Department of Oral Public Health, Institute of Dentistry, University of Eastern Finland, Kuopio, Finland

[4] Department of Oral and Maxillofacial Surgery, Kuopio University Hospital, Kuopio, Finland

[5] Oral and Maxillofacial Department, Oulu University Hospital, Oulu, Finland

Running title: Sense of coherence and periodontitis

Keywords: periodontal diseases; sense of coherence; cohort studies; adult; Finland

Corresponding Author:
Dr. Eduardo Bernabé,
Division of Population and Patient Health
King's College London Dental Institute
Denmark Hill Campus
Caldecot Road, London SE5 9RW, UK
Tel: +44 (0) 20 3299 3022
Email: eduardo.bernabe@kcl.ac.uk

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

SOURCE OF FUNDING

The Health 2000 Survey was organized by the National Institute for Health and Welfare (THL), formerly the National Public Health Institute (KTL), of Finland (http://www.terveys2000.fi/indexe.html), and partly supported by the Finnish Dental Society Apollonia and the Finnish Dental Association. The Follow-Up Study on Finnish Adults' Oral Health was funded by the Welfare and the Social Insurance Institution of Finland (KELA) abd organised by the National Institute for Health.

ABSTRACT

Aim: To assess whether sense of coherence (SOC) predicts the 4-year incidence of periodontal disease in adults.

Methods: Data from 848 adults who participated in both the Health 2000 Survey and the Follow-Up Study of Finnish Adults' Oral Health were analysed. At baseline, participants provided information on demographic characteristics, education level, the SOC scale, pre-existing diabetes and dental behaviours. The outcome measure was the change in number of teeth with pocketing≥4mm over four years over four years. Two separate sets of longitudinal analyses were conducted. The first set was conducted with all the 848 subjects who participated in both surveys and the second set was conducted with the 305 subjects who had no pocketing ≥4mm at baseline.

Results: In the full sample, baseline SOC was not associated with change in number of teeth with pocketing over four years (coefficient from linear regression: -0.28; 95% CI: -0.74 to 0.18). Similarly, baseline SOC was not associated with number of teeth with pocketing after four years (Rate Ratio: 0.94; 95%CI: 0.80 to 1.11) among those with no pocketing at baseline.

Conclusion: This 4-year prospective study suggests that SOC measured in adulthood does not explain change in the number of teeth with periodontal pocketing≥4mm.

CLINICAL RELEVANCE

Scientific rationale

Only two cross-sectional studies have explored the association between Sense of Coherence and periodontal disease among adults, with conflicting results.

Principal findings

This prospective study shows that Sense of Coherence may not be relevant to the understanding of periodontal disease.

Practical implications

This study excludes Sense of Coherence from the pool of candidate psychosocial factors that have been linked to periodontal disease.

INTRODUCTION

The salutogenesis theory refers to the factors that promote health in contrast to a pathogenic model of medicine where the focus is on the factors of disease (Antonovsky, 1979, Antonovsky, 1987). Identifying why people are healthy or remain healthy in adverse conditions or stressful situations may suggest what regulates health (Antonovsky, 1996, Eriksson and Lindstrom, 2006). The Sense of Coherence (SOC) construct is central to the salutogenesis theory and relates to the way individuals make sense of the world, use required resources to respond to it and feel that these responses are meaningful and make sense emotionally (Antonovsky, 1987). As such, a strong SOC has been hypothesised to facilitate successful coping with stressors and the maintenance and improvement of health (Antonovsky 1996, Eriksson and Lindstrom 2006). Supporting the contribution of SOC to health, various prospective studies have shown that stronger SOC predicts better health outcomes in adult life (Poppius et al., 1999, Kivimäki et al., 2000, Suominen et al., 2001, Poppius et al., 2003, Surtees et al., 2003, Kouvonen et al., 2008, Konttinen et al., 2008, Kouvonen et al., 2010).

A number of studies also support an association between a strong SOC and better clinical oral health in adults (Lindmark et al., 2011, Bernabé et al., 2010, Bernabé et al., 2012b, Bernabé et al., 2012a). However, evidence on SOC and periodontal disease is still conflicting. Only two studies, both cross-sectional, have explored the association of SOC with periodontal disease in adults. Using data from the nationally representative Health 2000 Survey of adults in Finland, Bernabé et al. (2010) found that the association of SOC with the extent of periodontal pockets≥4mm was fully accounted for by pre-existing diabetes, oral health-related behaviours and dental plaque. Contrarily, Lindmark et al. (2011), using data from the 2003 survey of the Jonkoping study in Sweden found that SOC was associated with fewer teeth with pockets≥4mm after adjusting for potential confounders. In the only longitudinal study to date, Ayo-Yusuf et al. (2008) found that a strong SOC was an independent predictor of self-reported frequent gingival bleeding in South African adolescents over an 18-month period.

Antonovsky (1987, 1996) proposed that SOC could promote health through three pathways: first, by regulating emotional tension generated by confrontation with stressors; second, through the selection of health-promoting behaviours; and third, by direct physiological consequences via the central pathways of the neuro-immune and endocrine systems. Most oral diseases have a strong behavioural component, and as such, Antonovsky's second proposed pathway may determine the health-promoting and avoidance patterns that are associated with periodontal disease. More specifically,

Studies have shown that adults with a strong SOC are more likely to brush their teeth daily (Savolainen et al., 2005), visit the dentist regularly for check-ups (Savolainen et al., 2004), and avoid smoking habits (Wainwright et al., 2007, Savolainen et al., 2009). On the other hand, researchers in the medical field have shown that SOC correlates with emotional states (Julkunen and Ahlstrom, 2006, Kivimäki et al., 2002) and markers of inflammation (Lindfors et al., 2006, Nasermoaddeli et al., 2006, Garvin et al., 2009), both of which are known to play a role in periodontal disease.

Therefore, the purpose of this study was to assess whether SOC predicts 4-year incidence of periodontal disease in Finnish adults. It was hypothesized that a weak SOC will lead to an increase in the 4-year incidence of periodontal disease.

MATERIALS AND METHODS

Data source

The Health 2000 Survey was a national survey conducted by the National Public Health Institute (currently THL - National Institute of Health and Welfare) in 2000-01. The stratified two-stage cluster sample was representative of the Finnish population and included 8028 subjects aged 30 years or over. The target sample size was calculated to allow determination of the prevalence of most health problems by various demographic groups (Aromaa and Koskinen, 2004). A total of 6335 subjects (79%) had clinical oral examinations. Of them, 5389 (85%) were dentate with complete data on dental status (Suominen-Taipale et al., 2008). In 2000, THL launched a series of population studies in collaboration with the Social Insurance Institution of Finland (KELA) to evaluate the effects of the dental care reform implemented in Finland in 2001-02. The Follow-Up Study on Finnish Adults' Oral Health was conducted in 2004-05 to assess the short-term effects of the reform on clinically determined oral health. For this survey, 2000 subjects were randomly selected from the list of participants who had attended the clinical oral health examinations in the Health 2000 Survey. People who died, were edentulous, and for logistic reasons, those in health centre districts where less than 15 subjects had been sampled, were excluded. The final sampling frame of the follow-up examinations comprised 1248 subjects who were invited to a clinical oral re-examination. The participation rate of the follow-up examinations was 84% (n=1049).

This study is based on 848 dentate adults who participated in both surveys and had complete data on the variables selected for analysis (representing 68% of the original sampling frame). The length of follow-up was approximately 4 years (mean: 1,504 days; range: 1,327-1,696).

Variables

At baseline, participants provided information on their demographic characteristics (sex and age), education, pre-existing diabetes, SOC scale and dental behaviours. Education level was indicated by a three-class variable. No vocational training beyond a vocational course or on the-job training with no matriculation examination was classified as basic education. Completion of vocational school as well as passing the matriculation examination but having no vocational training beyond a vocational course or on-the-job training was defined as secondary education. Higher education comprised degrees from higher vocational institutions, polytechnics, and universities. Pre-existing diabetes was determined based on information provided during the health interview. Participants were asked whether a doctor had ever diagnosed them with diabetes (no/yes).

Participants' SOC was assessed using a shortened version of the Finnish SOC-13 scale (Bernabé et al., 2012a, Bernabé et al., 2010, Savolainen et al., 2004, Savolainen et al., 2009, Savolainen et al., 2005, Bernabé et al., 2009). The item 'Does it happen that you have feelings inside you would rather not feel?' was not included in the final questionnaire of the Health 2000 Survey. Participants answered using 7-point semantic differential scales with two opposite anchoring phrases (1=very often and 7=very seldom or never). Negatively worded items were reverse-scored so that a high score indicated a strong SOC. Items were averaged to calculate the SOC score of each subject, which ranged between 1 and 7 points. When calculating the SOC score, subjects with missing values for more than 3 SOC items were treated as missing. If a subject had 3 or less SOC items with missing values, they were replaced by the mean value of the remaining SOC items for that subject. In this sample, Cronbach's alpha for the SOC scale was 0.85.

In terms of dental behaviours, participants reported their pattern of dental attendance on a 3-point scale (never, only for emergencies, regularly for check-ups) and their toothbrushing frequency on a 5-point scale (never, less often than every day, once a day, twice a day, more than twice a day). Smoking status was derived from four questions: 'have you ever smoked?', 'have you ever smoked regularly (i.e. daily for at least 1 year)?', 'have you smoked at least 100 times?' and 'when did you last

smoke?'. Daily smokers were defined as those who reported smoking at least 100 times in their lifetime, regularly for at least 1 year and most recently the day of the survey or the previous day.

Clinical oral examinations were conducted identically at baseline and follow-up. Baseline examinations were performed by 5 dentists using a headlamp, mouth mirror, fibre-optic light and a WHO periodontal probe, with participants seated on a dental unit. Follow-up examinations were performed by one of the dentists who participated at baseline. The periodontal status was determined by measuring the depth of periodontal pockets on four sites per tooth (distal and midpoint on the buccal side, mesial and midpoint on the lingual side), excluding third molars and tooth remnants. All teeth with pocket depths of 4mm or more at any site were recorded as having periodontal pockets. The percentage agreement in the parallel measurements on 269 subjects, where field examiners were individually compared with the reference examiner under field circumstances, was 77% (Kappa: 0.41) for periodontal pockets by tooth. Kappa values for intra-examiner reliability on 111 subjects were 0.83 for periodontal pockets by tooth (Suominen-Taipale et al., 2004, Suominen-Taipale et al., 2008). The outcome measure was the change in number of teeth with pocketing≥4mm over four years, which was calculated by subtracting the number of teeth with pocketing at follow-up from the corresponding figure at baseline (for those teeth that were present and examined in both surveys).

Statistical Analysis

Two separate sets of longitudinal analyses were conducted. The first set was conducted with all the 848 subjects who participated in both surveys and had complete data. Simple linear regression was used for modelling the change in the number of teeth with pocketing in this set of analysis as the former was normally distributed, and had both positive and negative values. Regression coefficients were therefore reported. The second set was conducted with the 305 subjects who had no pocketing ≥4mm at baseline so that it gives a stronger indication of incidence of periodontal disease (positive change). Negative binomial regression was used for modelling the outcome measure in this set of analysis as it was a count variable with over-dispersion. Rate ratios (RR) were reported. The number of teeth at baseline, in its continuous form, was used as the offset variable in this set of regression models. Age and SOC were treated as continuous variables in all regression models.

The modelling strategy was first to estimate the crude, unadjusted association of SOC with the outcome measure and then gradually adjust for factors that could explain the association. Following

this strategy, the crude effect of baseline SOC on the change in number of teeth with pocketing was first estimated. This association was then sequentially adjusted for baseline demographic factors (sex and age) in Model 2, socioeconomic position (education level) in Model 3, and dental behaviours (dental attendance, tooth-brushing frequency and smoking status) and diabetes in Model 4.

RESULTS

The baseline profile of the two analytical samples is shown in Table 1. The sample of adults with complete data (n=848) was fairly similar to the full sample of adults who participated in the follow-up study (n=1048). In the former group, the mean number of teeth with pocketing at baseline was 4.1 (SD: 5.3, range 0-28), with 305 (36%) having no pocketing. The mean change in the number of teeth with pocketing was 2.5 (SD: 5.3, range: -18 to 21 teeth) with 16.3% showing no change. The subgroup of adults with no pocketing at baseline (n=305) included more female, slightly younger and more educated participants as well as fewer daily smokers. The mean change in the number of teeth with pocketing was 3.86 (SD: 4.18, range: 0-20) with 28.9% showing no change in pocketing.

Table 2 shows the distribution of SOC scores and change in number of teeth with pocketing by baseline characteristics. Among the 848 adults with complete data, more educated, non-diabetic and female participants as well as non-daily smokers, those who brushed their teeth twice a day or more often and those visiting the dentist regularly for check-ups had significantly higher SOC scores than their counterparts. The change in number of teeth with pocketing was significantly related to age and daily smoking. Among the 305 with no pocketing at baseline, women, non-daily smokers and more educated participants had significantly higher SOC scores than their counterparts. The change in number of teeth with pocketing was significantly related to sex, age and daily smoking.

SOC was not significantly associated with the change in number of teeth with pocketing over four years (Table 3). Among the 848 adults with complete data, a non-significant regression coefficient of -0.28 (95%CI: -0.74 to 0.18) was found between SOC and change in number of teeth with pocketing. This finding remained unchanged after adjustments for demographic factors (sex and age), socioeconomic position (education), behavioural factors (toothbrushing frequency, dental attendance pattern and smoking status) and pre-existing diabetes. Similarly, a non-significant rate ratio of 0.94 (95%CI: 0.80 to 1.10) was found for the association between SOC and change in the number of teeth

with pocketing among the 305 individuals with no pocketing at baseline. This finding did not change after adjustment for demographic factors, education, dental behaviours and diabetes.

DISCUSSION

In this prospective study on the association of SOC with clinical oral health in adults, SOC was not a predictor of 4-year incidence of periodontal disease. This finding was irrespective of analysing the full sample or only those with no evidence of periodontal disease at baseline.

Our findings agree with those from a previous study using data from the Finnish Health 2000 Survey (Bernabé et al., 2010) but disagree with a previous study in Sweden (Lindmark et al., 2011). The lack of association between SOC and periodontal disease may be explained by a number of factors. First, the Health 2000 Survey only included assessment for periodontal pocketing, which would probably result in an underestimate of the prevalence of periodontitis, especially among older people (Page and Eke, 2007). Clinical attachment loss is considered a more accurate measure and is accepted as the gold standard for disease severity and progression (Beck and Elter, 2000, Burt, 2005, Beltran-Aguilar et al., 2012, Savage et al., 2009). Second, the 4-year follow-up period may have been too short to note any changes in pocket depths for the development of periodontitis, although three years of data have shown differences when clinical attachment loss have been recorded (Burt, 2005). Third, using two points in time is the minimum amount of data for longitudinal analysis but may not be representative of any complex multi-factorial disease. Periodontal disease is characterised by intermittent bursts of activity, so it is possible that the number of examination times were not reflective of disease activity. A final explanation is that SOC is simply not relevant to periodontal disease. And even if significant findings are found with larger samples, the magnitude of the effect (6%-reduction in periodontally healthy adults) may be so small to be clinically important. As this is the first longitudinal study on the association between SOC and periodontal disease, further research is needed to corroborate the present findings. New studies will benefit from using alternative measures of periodontal disease and multiple periodontal assessments over longer follow-up periods.

Subject to replication in different populations, the present findings imply that policies and interventions to promote periodontal health may benefit little from considering the psychosocial characteristics encompassed by the SOC construct. Although prior research suggests that adults with a strong SOC tend to report more favourable dental behaviours, including those related to periodontal disease such

as smoking avoidance and frequent toothbrushing (Savolainen et al., 2005, Savolainen et al., 2004, Wainwright et al., 2007, Savolainen et al., 2009), most evidence to date is cross-sectional and it remains to be seen whether SOC is associated with changes in dental behaviours.

Some limitations of this study need to be discussed. First, the sample of adults who participated in the Follow-Up Study on Finnish Adults' Oral Health included slightly younger, more educated and more female participants than the baseline sample of the Health 2000 Survey. Therefore, our findings represent valid relationships between the variables of interest but cannot be inferred to the Finnish adult population. Second, due to a clerical error SOC was assessed using 12 of the 13 items of the original short SOC scale. Despite being different in only one item from the original scale, it is possible that this modified instrument, widely used among Finnish adults (Bernabé et al., 2012a, Bernabé et al., 2010, Savolainen et al., 2004, Savolainen et al., 2009, Savolainen et al., 2005), may have measured a phenomenon that is similar but not identical to Antonovsky's SOC construct. However, this abbreviated SOC scale has good structural validity and internal consistency (Bernabé et al., 2009). In addition, a 4-year prospective study found similar results for the association between SOC and health when using the SOC-13 or even a shorter six-item version (Kivimäki et al., 2000). Third, the inter-examiner agreement for periodontal pockets was only moderate, which implies that it was prone to measurement bias. This is not a unique characteristic of this survey, but rather a standard feature across epidemiological surveys, reflecting the difficulty to examine and precisely measure periodontal pockets under field circumstances.

In conclusion, this prospective study did not support an association between Sense of Coherence and number of teeth with periodontal pocketing among Finnish adults.

REFERENCES

Antonovsky, A. (1979) *Health, stress and coping*. San Francisco (CA): Jossey-Bass.

Antonovsky, A. (1987) *Unravelling the mystery of health: how people manage stress and stay well*. California: Jossey-Bass.

Antonovsky, A. (1996) The salutogenic model as a theory to guide health promotion. *Health Prom Int* **11,** 11-18.

Aromaa, A. & Koskinen, S. (2004) Health and functional capacity in Finland. Baseline results of the Health 2000 health examination survey. Helsinki: Publications of the National Public Health Institute B12/2004. http://www.terveys2000.fi/julkaisut/baseline.pdf.

Ayo-Yusuf, O. A., Reddy, P. S. & van den Borne, B. W. (2008) Adolescents' sense of coherence and smoking as longitudinal predictors of self-reported gingivitis. *J Clin Periodontol* **35,** 931-937. doi:10.1111/j.1600-051X.2008.01319.x.

Beck, J. D. & Elter, J. R. (2000) Analysis strategies for longitudinal attachment loss data. *Community Dent Oral Epidemiol* **28,** 1-9. doi:10.1034/j.1600-0528.2000.280101.x.

Beltran-Aguilar, E. D., Eke, P. I., Thornton-Evans, G. & Petersen, P. E. (2012) Recording and surveillance systems for periodontal diseases. *Periodontol 2000* **60,** 40-53. doi:10.1111/j.1600-0757.2012.00446.x.

Bernabé, E., Newton, J. T., Uutela, A., Aromaa, A. & Suominen, A. L. (2012a) Sense of coherence and four-year caries incidence in Finnish adults. *Caries Res* **46,** 523-529. doi:10.1159/000341219.

Bernabé, E., Tsakos, G., Watt, R. G., Suominen-Taipale, A. L., Uutela, A., Vahtera, J. & Kivimaki, M. (2009) Structure of the sense of coherence scale in a nationally representative sample: the Finnish Health 2000 survey. *Qual Life Res* **18,** 629-636. doi:10.1007/s11136-009-9469-z.

Bernabé, E., Watt, R. G., Sheiham, A., Suominen-Taipale, A. L., Uutela, A., Vehkalahti, M. M., Knuuttila, M., Kivimaki, M. & Tsakos, G. (2010) Sense of coherence and oral health in dentate adults: findings from the Finnish Health 2000 survey. *J Clin Periodontol* **37,** 981-987. doi:10.1111/j.1600-051X.2010.01604.x.

Bernabé, E., Watt, R. G., Sheiham, A., Suominen, A. L., Vehkalahti, M. M., Nordblad, A., Uutela, A., Kivimaki, M. & Tsakos, G. (2012b) Childhood socioeconomic position, adult sense of coherence and tooth retention. *Community Dent Oral Epidemiol* **40,** 46-52. doi:10.1111/j.1600-0528.2011.00633.x.

Burt, B. (2005) Position paper: epidemiology of periodontal diseases. *J Periodontol* **76,** 1406-1419. doi:10.1902/jop.2005.76.8.1406.

Eriksson, M. & Lindstrom, B. (2006) Antonovsky's sense of coherence scale and the relation with health: a systematic review. *J Epidemiol Community Health* **60,** 376-381. doi:10.1136/jech.2005.041616.

Garvin, P., Nilsson, L., Carstensen, J., Jonasson, L. & Kristenson, M. (2009) Plasma levels of matrix metalloproteinase-9 are independently associated with psychosocial factors in a middle-aged normal population. *Psychosom Med* **71,** 292-300. doi:10.1097/PSY.0b013e3181960e7f.

Julkunen, J. & Ahlstrom, R. (2006) Hostility, anger, and sense of coherence as predictors of health-related quality of life. Results of an ASCOT substudy. *J Psychosom Res* **61,** 33-39. doi:10.1016/j.jpsychores.2005.12.005.

Kivimäki, M., Elovainio, M., Vahtera, J., Nurmi, J. E., Feldt, T., Keltikangas-Jarvinen, L. & Pentti, J. (2002) Sense of coherence as a mediator between hostility and health: seven-year prospective study on female employees. *J Psychosom Res* **52,** 239-247. doi:10.1016/S0022-3999(01)00305-1.

Kivimäki, M., Feldt, T., Vahtera, J. & Nurmi, J. E. (2000) Sense of coherence and health: evidence from two cross-lagged longitudinal samples. *Soc Sci Med* **50,** 583-597. doi:10.1016/S0277-9536(99)00326-3.

Konttinen, H., Haukkala, A. & Uutela, A. (2008) Comparing sense of coherence, depressive symptoms and anxiety, and their relationships with health in a population-based study. *Soc Sci Med* **66,** 2401-2412. doi:10.1016/j.socscimed.2008.01.053.

Kouvonen, A. M., Vaananen, A., Vahtera, J., Heponiemi, T., Koskinen, A., Cox, S. J. & Kivimaki, M. (2010) Sense of coherence and psychiatric morbidity: a 19-year register-based prospective study. *J Epidemiol Community Health* **64,** 255-261. doi:10.1136/jech.2008.083352.

Kouvonen, A. M., Vaananen, A., Woods, S. A., Heponiemi, T., Koskinen, A. & Toppinen-Tanner, S. (2008) Sense of coherence and diabetes: a prospective occupational cohort study. *BMC Public Health* **8,** 46. doi:10.1186/1471-2458-8-46.

Lindfors, P., Lundberg, O. & Lundberg, U. (2006) Allostatic load and clinical risk as related to sense of coherence in middle-aged women. *Psychosom Med* **68,** 801-807. doi:10.1097/01.psy.0000232267.56605.22.

Lindmark, U., Hakeberg, M. & Hugoson, A. (2011) Sense of coherence and oral health status in an adult Swedish population. *Acta Odontol Scand* **69,** 12-20. doi:10.3109/00016357.2010.517553.

Nasermoaddeli, A., Sekine, M. & Kagamimori, S. (2006) Gender differences in associations of C-reactive protein with atherosclerotic risk factors and psychosocial characteristics in Japanese civil servants. *Psychosom Med* **68,** 58-63. doi:10.1097/01.psy.0000195882.00407.05.

Page, R. C. & Eke, P. I. (2007) Case definitions for use in population-based surveillance of periodontitis. *J Periodontol* **78,** 1387-1399. doi:10.1902/jop.2007.060264.

Poppius, E., Tenkanen, L., Hakama, M., Kalimo, R. & Pitkanen, T. (2003) The sense of coherence, occupation and all-cause mortality in the Helsinki Heart Study. *Eur J Epidemiol* **18,** 389-393. doi:10.1023/A:1024213427147.

Poppius, E., Tenkanen, L., Kalimo, R. & Heinsalmi, P. (1999) The sense of coherence, occupation and the risk of coronary heart disease in the Helsinki Heart Study. *Soc Sci Med* **49,** 109-120. doi:10.1016/S0277-9536(99)00105-7.

Savage, A., Eaton, K. A., Moles, D. R. & Needleman, I. (2009) A systematic review of definitions of periodontitis and methods that have been used to identify this disease. *J Clin Periodontol* **36,** 458-467. doi:10.1111/j.1600-051X.2009.01408.x.

Savolainen, J., Knuuttila, M., Suominen-Taipale, L., Martelin, T., Nordblad, A., Niskanen, M. & Uutela, A. (2004) A strong sense of coherence promotes regular dental attendance in adults. *Community Dent Health* **21,** 271-276.

Savolainen, J., Suominen-Taipale, A., Uutela, A., Aromaa, A., Harkanen, T. & Knuuttila, M. (2009) Sense of coherence associates with oral and general health behaviours. *Community Dent Health* **26,** 197-203. doi:10.1922/CDH_2335Savolainen07.

Savolainen, J., Suominen-Taipale, A. L., Uutela, A. K., Martelin, T. P., Niskanen, M. C. & Knuuttila, M. L. (2005) Sense of coherence as a determinant of toothbrushing frequency and level of oral hygiene. *J Periodontol* **76,** 1006-1012. doi:10.1902/jop.2005.76.6.1006.

Suominen-Taipale, A. L., Nordblad, A., Vehkalahti, M. & Aromaa, A. (2004) Suomalaisten Aikuisten Suunterveys, Terveys 2000–Tutkimus. Helsinki: Publications of the National Public Health Institute B16/2004. http://www.ktl.fi/attachments/suomi/julkaisut/julkaisusarja_b/2004b16.pdf.

Suominen-Taipale, A. L., Nordblad, A., Vehkalahti, M. & Aromaa, A. (2008) Oral Health in the Finnish adult population. Health 2000 survey. Helsinki: Publications of the National Public Health Institute B 25/2008. http://www.ktl.fi/attachments/suomi/julkaisut/julkaisusarja_b/2008/2008b25.pdf.

Suominen, S., Helenius, H., Blomberg, H., Uutela, A. & Koskenvuo, M. (2001) Sense of coherence as a predictor of subjective state of health: results of 4 years of follow-up of adults. *J Psychosom Res* **50,** 77-86. doi:10.1016/S0022-3999(00)00216-6.

Surtees, P. G., Wainwright, N., Luben, R., Khaw, K. T. & Day, N. (2003) Sense of coherence and mortality in men and women in the EPIC-Norfolk United Kingdom prospective cohort study. *Am J Epidemiol* **158,** 1202-1209. doi:10.1093/aje/kwg272.

Wainwright, N. W., Surtees, P. G., Welch, A. A., Luben, R. N., Khaw, K. T. & Bingham, S. A. (2007) Healthy lifestyle choices: could sense of coherence aid health promotion? *J Epidemiol Community Health* **61,** 871-876. doi:10.1136/jech.2006.056275.

Table 1. Characteristics of participants included in the two set of analysis

Baseline characteristics	Full follow-up sample (n=1,049)		All adults with complete data (n=848)		Adults with no pocketing at baseline (n=305)	
	n	(%)	n	(%)	n	(%)
Sex						
Men	476	45%	385	45%	106	35%
Women	573	55%	463	55%	199	65%
Mean age ±SD, years	48.7 ± 12.1		47.6 ± 11.5		45.6 ± 11.6	
Education						
Basic	295	28%	229	27%	70	23%
Secondary	381	36%	321	38%	113	37%
Higher	368	35%	298	35%	122	40%
Diabetes						
Yes	1000	96%	818	96%	292	96%
No	45	4%	30	4%	13	4%
Mean SOC score ± SD	5.5 ± 0.8		5.5 ± 0.8		5.6 ± 0.7	
Daily smoking						
No	807	77%	663	78%	253	83%
Yes	238	23%	185	22%	52	17%
Toothbrushing frequency						
Once a day or less	333	33%	287	34%	105	34%
Twice a day or more	665	67%	561	66%	200	66%
Dental attendance pattern						
Only for emergencies/never	395	39%	319	38%	108	35%
Regularly for check-ups	606	61%	529	62%	197	65%

Table 2. SOC scores and change in number of teeth with pocketing among adults with complete data and those with no pocketing at baseline

Baseline characteristics	All adults with complete data (n=848)		Adults with no pocketing at baseline (n=305)	
	SOC score	Pocketing	SOC score	Pocketing
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Sex				
Men	5.6 (0.8)	2.9 (6.0)	5.7 (0.8)	4.6 (4.7)
Women	5.5 (0.8)*	2.2 (4.6)	5.5 (0.8)*	3.4 (3.7)*
Age in years	-0.02	-0.14***	-0.10	-0.16**
Education				
Basic	5.4 (0.9)	2.4 (5.5)	5.4 (0.9)	4.1 (4.6)
Secondary	5.5 (0.7)*	2.6 (5.4)	5.6 (0.7)*	4.0 (3.9)
Higher	5.6 (0.7)***	2.6 (5.0)	5.6 (0.7)*	3.5 (4.0)
Diabetes				
No	5.6 (0.8)	1.5 (4.1)	5.6 (0.8)	3.5 (3.5)
Yes	5.2 (0.7)*	2.6 (5.3)	5.2 (0.8)	3.8 (4.2)
Daily smoking				
No	5.6 (0.7)	2.2 (4.8)	5.6 (0.7)	3.3 (3.7)
Yes	5.4 (0.9)**	3.8 (6.5)***	5.4 (0.9)*	6.3 (4.9)***
Toothbrushing frequency				
Once a day or less often	5.4 (0.8)	3.0 (5.4)	5.5 (0.7)	4.0 (4.1)
Twice a day or more often	5.6 (0.8)*	2.3 (5.2)	5.6 (0.8)	3.7 (4.2)
Dental attendance pattern				
Only for emergencies/never	5.5 (0.8)	2.6 (5.4)	5.5 (0.7)	4.1 (4.2)
Regularly for check-ups	5.6 (0.8)**	2.5 (5.2)	5.6 (0.8)	3.6 (4.1)

Stars indicate significant differences when compared to reference (first) category.
* p<0.05; ** p<0.01; ***p<0.001

Table 3. Association between baseline SOC score and 4-year change in number of teeth with pocketing in adults with complete data and those with no pocketing at baseline

Model[c]	All adults with complete data (n=848)			Adults with no pocketing at baseline (n=305)		
	Coef.[a]	(95% CI)	p value	RR[b]	(95% CI)	p value
Model 1	-0.28	(-0.74 to 0.18)	0.231	0.94	(0.80 to 1.11)	0.480
Model 2	-0.34	(-0.79 to 0.11)	0.140	0.93	(0.78 to 1.10)	0.371
Model 3	-0.32	(-0.77 to 0.14)	0.176	0.96	(0.81 to 1.14)	0.663
Model 4	-0.25	(-0.71 to 0.21)	0.289	1.00	(0.85 to 1.19)	0.966

[a] Linear regression models were fitted and regression coefficients (Coef.) reported.
[b] Negative binomial regression models were fitted and rate ratios (RR) reported.
[c] Model 1 was unadjusted; Model 2 adjusted for sex and age (continuous); Model 3 adjusted for sex, age and education; and Model 4 adjusted for sex, age, education, dental attendance pattern, tooth-brushing frequency, smoking status and pre-existing diabetes.